The Journal
of Research
on the Lepidoptera

Volume 44: 1-16

THE LEPIDOPTERA RESEARCH FOUNDATION, 29 April 2011

ISSN 0022-4324 (print)
ISSN 2156-5457 (online)

New and revised descriptions of the immature stages of some butterflies in Sri Lanka and their larval food plants (Lepidoptera: Nymphalidae). Part 1: Sub-family Danainae

George van der Poorten and Nancy van der Poorten
17 Monkton Avenue, Toronto, Ontario M8Z 4M9 Canada
nmgvdp@netscape.net

Abstract. The immature stages of the 12 species of butterflies of the subfamily Danainae and their larval food plants in Sri Lanka are presented. The immature stages of six species and their larval food plants are documented for the first time. The immature stages of the remaining six species that have been previously described from Sri Lankan material are compared to findings of the current study and additional observations are presented. For these six species, new larval food plants are reported for the first time. For two of these species, larval food plants previously reported in Sri Lanka are confirmed. This study provides the basic information for further studies on the biology of these species. It also provides information for conservation management programs for butterflies in Sri Lanka.

Keywords: Immature stages, larval food plants, Sri Lanka, Ceylon, Danainae, Lepidoptera, butterflies, conservation.

Introduction

The first butterfly described from Sri Lanka (then known as Ceylon) was *Papilio hector* (now *Pachliopta hector*) by Linnaeus in 1758 (d'Abrera, 1998). In 1861, Sir J. Emerson Tennent listed a few butterflies known from the island in his book Sketches of the Natural History of Ceylon. Several major works followed, most notably Moore (1880, 1881) and Woodhouse in several editions (1942, 1949, 1950) (Appendix A) but the immature stages and larval food plants of many species were undescribed or described only briefly.

Woodhouse (1950) published descriptions of the immature stages of 191 species of butterflies in the island out of a total of 242. Of these descriptions, 80 were based on work done in Sri Lanka (mostly based on Moore (1880) and published and unpublished accounts of E. E. Green, Tunnard, Manders and Wiley) and 111 were based on work done in peninsular India by Bell, Marshall, de Nicéville and others. The immature stages of 51 species (including endemics and non-endemics) still remained unknown and undescribed in Woodhouse.

Little work has been published since Woodhouse though several individuals have reared many of the undescribed species of butterflies. Unfortunately, several recent books have repeated information from Woodhouse uncritically and so have propagated errors and misinformation. Many of the larval food plants used in India either do not occur in Sri Lanka or are not used by the same species in Sri Lanka or if it is used, it is not the preferred plant.

Sri Lanka is an island off the tip of India and is considered geographically and zoogeographically as part of the Indian subcontinent. Sri Lanka and the Western Ghats in India are considered one of the 25 biodiversity hotspots in the world by Conservation International. The island is broadly divided into 7 climatic zones (Fig. 1) (Sri Lanka, Ministry of Foresty and Environment, 1999). The arid zone (altitude 0-100 m) occurs as a small strip of land on the north-west coast and on the south-east coast. Rainfall is less than 1250 mm per year, occuring mainly from October to January with more than 5 dry months (less than 50 mm rainfall per month). The dry zone (altitude 0-500 m) covers most of the north and south-east of the island. Rainfall is 1250-1900 mm per year,

Received: 11 February 2011
Accepted: 23 March 2011

occuring mainly from October to January with 4-5 dry months per year (less than 50 mm rainfall per month). The intermediate zone (altitude 0-1000 m) is found between the dry and wet zones. Rainfall is 1900-2500 mm per year with fewer than 3 dry months (less than 50 mm rainfall per month). The lowland wet zone (altitude 0-1000 m) covers the south-west coast and the central regions. Rainfall is 2500-5000 mm per year and there are no dry months. The submontane wetlands (altitude 1000-1500 m) receive 2500-5000 mm of rain per year with no dry months. The wet highlands (altitude 1500-2500 m) receive 2500-5000 mm of rain per year with no dry months. The intermediate highlands (altitude 1000-1500 m) receive 1900-2500 mm of rain per year with fewer than 3 dry months (less than 50 mm rainfall per month).

In the current study (conducted from 2004 to the present and ongoing), we have documented the immature stages and larval food plants of 162 of the 245 known species of butterflies in Sri Lanka.

In Part 1, we present the immature stages and larval food plants of the 12 species of the family Nymphalidae, subfamily Danainae, tribe Danaini. The immature stages of 6 species and their larval food plants in Sri Lanka are documented for the first time. The immature stages of the remaining 6 species have been previously described from Sri Lankan material. These descriptions are compared to the findings of the current study and additional observations are presented. For these six species, new larval food plants are reported for the first time. For two of these species, larval food plants previously reported in Sri Lanka are confirmed.

Adapted from: Sri Lanka, Ministry of Forestry & Environment, 1999.

Figure 1. Climatic zones of Sri Lanka

Materials and methods

Eggs, larvae and/or pupae were collected in the field and raised to eclosion in suitable containers with the larval food plant. Wherever possible, a potted plant covered with netting was used to rear the larvae in order to provide as natural a setting as possible to observe behavior and to provide a more natural place for the larva to pupate. If potted plants were not available, stems or branches of the plant were kept in a bottle of water and placed under netting. When the stem or branch was consumed or no longer suitable, new ones were introduced into the bottle alongside the old ones so that the larva could transfer to the fresh plant material on its own. Otherwise, pieces of the larval food plant were placed into a container with the larva and replenished as necessary, as in the case of flowers, fruits and mealy bugs. Twigs, leaves, branches, or soil were provided as necessary for the mature larva to pupate. All adults that eclosed normally were released to their place of origin. A plant was determined to be a true larval food plant if the larva successfully emerged as an adult.

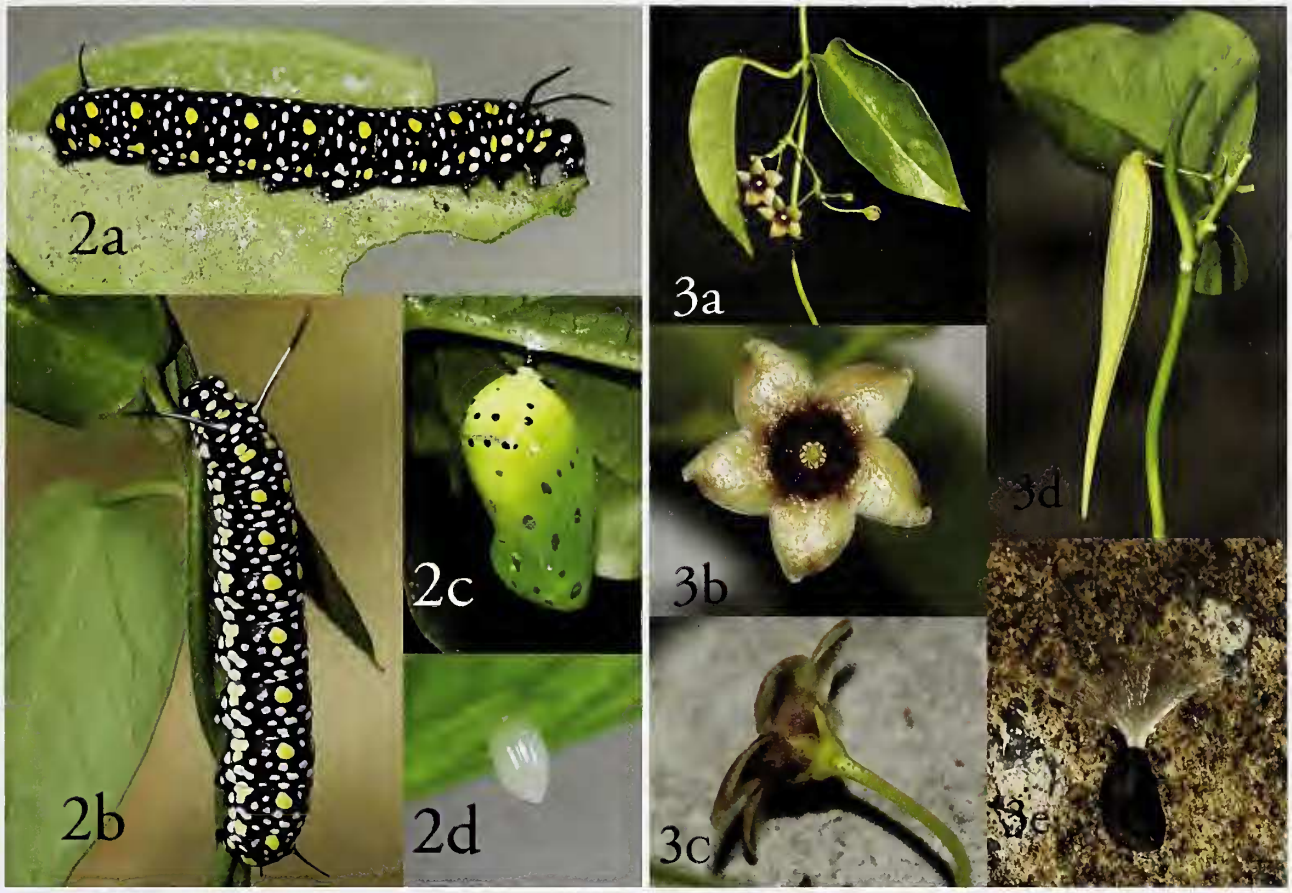
Conventions used: Segments are numbered S1 to S14 (S1 is the head; S2–4 are the 3 segments of the thorax and S5–14 are the 10 segments of the abdomen). These are applied to both the larva and the pupa.

Results and discussion

Tribe: Danaini
Sub-tribe: Danaina

Parantica aglea aglea (Stoll, 1782) (Glassy Tiger)

The final instar larva and pupa of *Parantica aglea aglea* were described by Moore (1880) from Sri Lankan material. The larva and pupa of *P. aglea* were described by Bell (1909) from Indian material and quoted in Woodhouse (1950). These descriptions agree with the findings of the current study except for the following points: in *P. a. aglea*, a) in the larva,



Figures 2-3. **2**. *Parantica aglea aglea*. **2a**. Larva, final instar feeding on *Tylophora indica*. **2b**. Larva, final instar feeding on "kiri anguna." **2c**. Pupa. **2d**. Egg. **3**. Kiri anguna. **3a**. Inflorescence and leaves. **3b**. Flower. **3c**. Flower (ventral view) and calyx. **3d**. Seed pod. **3e**. Seed.

the filaments on S3 are black with white on the inside for about half the length, and the filaments on S12 are all black (not claret red as in Bell) (Fig. 2a, b); and b) the pupa often has a transverse silver line on S7 connecting the black spots (Fig. 2c).

Additional notes on immature stages: Egg: white, elongate, tapered to the apex, flattened at base, 18 longitudinal ribs with numerous fine transverse ridges (Fig. 2d). Duration of immature stages: pupation to eclosion 9 days; hatching to eclosion 22 days.

Larval food plants: In Sri Lanka, "*Cryptolepis*, &c" was reported by Moore (1880) and "*Calotropis*" was reported by Thwaites (Moore, 1890-92). In addition, *Tylophora tenuissima* was recorded by Woodhouse (1950), based on Bell (1909) reporting from India.

The current study showed for the first time that the following are larval food plants in Sri Lanka: *Tylophora tenuissima*, *Tylophora indica*, *Heterostemma* cf *tanjorense* and two additional as yet unidentified plant species of the family Asclepiadaceae. The authors have successfully reared *P. a. aglea* on a plant called kiri anguna in Sinhalese (note that in Sri Lanka, many different species have the local common name of kiri anguna). This plant is extensively cultivated in Sri Lanka as a green vegetable and is probably an introduced plant, likely a species of *Tylophora* (Fig. 3a–e). The other unidentified plant is a vine found in Wellawaya (H. D. Jayasinghe, pers. comm.) but flowers and fruits have not yet been seen. In the current study, the larvae of *P. a. aglea* that were collected from many different locations refused to feed on *Cryptolepis buchananii* or *Calotropis gigantea*.

P. a. aglea is common over most of the island and is also seen in the higher elevations where these larval food plants are not found. *P. a. aglea* is a migratory species and it is possible that the butterflies that are seen in the higher elevations are simply passing through. If they are breeding residents, there must be another larval food plant.

Figures 4-5. 4. *Parantica taprobana*. **4a**. Larva, final instar feeding on *Cynanchum alatum*, lateral view. **4b**. Larva, final instar, feeding on *Cynanchum alatum*, dorsal view. **4c**. Pupa. **4d**. Eggs. **5**. *Ideopsis similis exprompta*. **5a**. Egg. **5b**. Larva, first instar. **5c**. Larva, second instar, feeding on *Tylophora indica*. **5d**. Larva, third instar. **5e**. Larva, final instar. **5f**. Pupa, ventro-lateral view. **5g**. Pupa, dorso-lateral view.

Parantica taprobana (Felder & Felder, 1865) (Sri Lankan Tiger)

The final instar larva and pupa of *Parantica taprobana* (endemic to Sri Lanka) were described briefly by Tunnard (Woodhouse, 1950) from Sri Lankan material. This description of the larva agrees with the findings of the current study except for the following points: in *P. tabrobana*, a) the larvae are purplish-brown with white and yellow markings (not "black and white"), b) subspiracular line yellow, c) S2–S13 with a yellow subdorsal spot, d) S14 with a white subdorsal spot which sometimes coalesces to form a band, e) filaments on S3 slope forwards while those on S12 slope backwards or are held almost vertically, f) filaments black with white inside and outside along the entire length, and g) large, white triangular spot at the apex of the clypeus (Fig. 4a, b).

Tunnard's description of the pupa agrees with the findings of the current study except for the following points: in *P. tabrobana*, a) black spots on S7 embedded on a wide silver-colored transverse band, b) S8 with 6 black spots, c) S9 with no spots, d) S13 with 2 black spots, e) cremaster black, f) S5 with 2 silver spots, g) S6 with 5 silver spots, h) S4 with no markings, i) S3 with 8 large silver spots, j) eye with one silver spot and k) several silver spots on the wings. The pupa is very similar to that of *P. aglea aglea* but *P. taprobana* is more cone-shaped from the last abdominal segment to the widest segment of the abdomen (rounded in *P. aglea aglea*) and the silver spots are usually larger and more extensive (Fig. 4c). These observations indicate that the larva and pupa are much more variable than described by Tunnard.

Additional notes on immature stages: Egg: white, elongate, tapered to apex, broadly flattened at base, longitudinal ribs with numerous fine transverse ridges (Fig. 4d). 1st instar: Newly emerged larva—head

black, body grayish, tiny filaments on S3 and S12; ate most of eggshell, then rested for several hours. One day later—body uniformly brownish gray, white transverse lines, white subdorsal and sublateral spots; ate stem as well as leaves; never very active.

Duration of immature stages: oviposition to emergence 4–5 days; emergence to 1st molt 3–5 days; 2nd instar 6.5 mm length; 1st to 2nd molt 2–3 days; 3rd instar 9 mm length; 2nd to 3rd molt 3–4 days; 4th instar 19 mm length; 3rd to 4th molt not recorded; 5th instar 30 mm length; 4th molt to pupation not recorded; length at pupation 40 mm; emergence to pupation 18–26 days; pupation to eclosion not recorded.

Larval food plants: In Sri Lanka, Manders (1903) reported that *P. taprobana* had been "frequently bred by Mr. Green, myself and others...on *Tylophora asthmatica*" [now *T. indica*] (family Asclepiadaceae). Tunnard tentatively identified the larval food plant in his study as *Ceropegia thwaitesii* (family Asclepiadaceae). Mackwood (1919) published a second-hand report that the larva feeds on *Allaeophania decipiens* (family Rubiaceae) [now *Metabolus decipiens*].

The current study showed for the first time that one of the larval food plants in Sri Lanka is *Cynanchum alatum* (family Asclepiadaceae). *Cy. alatum* has been reported from only two locations in Sri Lanka—Maturata and Hakgala (Dassanayake, 1983). However, in the current study, *P. taprobana* was seen ovipositing on *Cy. alatum* near Ambawella (Nuwara Eliya) and the plant was quite abundant along the roadsides. It is possible that *Cy. alatum* is more widespread than previously believed.

Larvae have also been found on a plant that has not yet been unidentified—in Haputale, *P. taprobana* was reared on an asclepid which is likely a species of *Tylophora* (S. Sanjeewa, pers. comm.).

Another possible larval food plant is *Tylophora cordifolia*. The authors observed a ♀ ovipositing on this plant in the Knuckles area but were not able to confirm that the larvae actually fed on this plant. Eggs that were collected did not hatch and no larvae or pupae were seen on the plant at subsequent visits.

Neither *Ceropegia thwaitesii* nor *M. decipiens* have been confirmed as a larval food plant. *Ce. thwaitesii* is a rare plant of the moist hill country and has not been found by any recent collector (Dassanayake, 1983). However since it is found in the range of *P. taprobana*, it is possible that it, or another species of *Ceropegia*, is a larval food plant. *M. decipiens* is probably not a larval food plant since no members of the family Rubiaceae are known to be used by species of *Parantica*. In the current study, we have been unable to confirm whether or not *T. indica* is a larval food plant, though it is very likely.

P. taprobana is common above 1200 m asl though it is found as low as 800 m asl.

Ideopsis similis exprompta Butler, 1874 (Blue Glassy Tiger)

There are no records of the immature stages of *Ideopsis similis exprompta*. In the current study, the immature stages are described for the first time.

Notes on immature stages: On January 26, 2006, the authors observed a ♀ in a coconut land on the west coast near Pamunugama oviposit on a plant that was later identified as *Parsonsia alboflavescens* (family Apocynaceae). The eggs were laid singly on the underside of the leaves. The ♀ spent considerable time flying slowly near the plant before it oviposited. Three larvae emerged from these eggs but refused to feed on *P. alboflavescens* on which they were laid. They readily ate the leaves of *Tylophora indica* (family Asclepiadaceae) and emerged as normal adults after pupation. *I. s. exprompta* was subsequently observed ovipositing on *T. indica* in the Sinharaja Forest Reserve. The larvae fed on *T. indica* and adults emerged successfully and were released back into the forest.

Egg: white, elongate, tapering to the apex, flattened at base, 12 longitudinal ribs with numerous fine transverse ridges (Fig. 5a). 1st instar: Newly emerged larva—head black, abdomen translucent with many fine, light-pink transverse lines along its length, small pink stubby filaments on S3 and S12, feeds on the eggshell as its first meal (Fig. 5b). 2nd instar: body light brownish-red with whitish spots all over, filaments brownish-red and slightly longer (Fig. 5c). 3rd instar: body purplish-brown with small whitish indistinct spots, filaments purplish-brown and longer (Fig. 5d). 4th instar: Not recorded. 5th instar: head black, body dark purplish-brown with small well-defined white to cream-colored spots, filaments black with claret-red bases and longer (Fig. 5e). The larva remains on the underside of a leaf near the ground and is rarely seen in the open.

Pupa: Pupation on the underside of fresh leaves near the ground. Pupa green with black and silver markings. Very similar to that of the *Parantica aglea aglea* but on S2 of *I. similis exprompta* there is a pair of silver spots with large black centers; on S5 above the silver line, only a single pair of black spots laterally below the spiracles (Fig. 5f-g).

Duration of immature stages: oviposition to emergence 3–5 days; molt (4 molts) every 2–4 days; length before pupation 35 mm; hatching to pupation 12–20 days; pupation to eclosion 7 days; hatching to eclosion 19–27 days.

Larval food plants: There are no published records

of the larval food plant in Sri Lanka. The current study showed for the first time that one of the larval food plants in Sri Lanka is *Tylophora indica* (family Asclepiadaceae).

T. indica is widely distributed over the island in all climatic zones up to about 1000 m asl though it is less common at the higher elevations.

I. s. exprompta occurs in the wet zone below 500 m asl but is restricted to the south-west coast from Negombo to Galle. Within this range, it occurs most commonly within a few kilometers of the coast, especially in mangrove and marsh habitats. However, it also occurs further inland in forest reserves such as Sinharaja, Morapitiya and Kanneliya. The reason for the very restricted distribution of *I. s. exprompta* despite the very wide distribution and availability of its larval food plant is not clear. There are also some locations (e.g. Sri Jayawardenapura) where *I. s. exprompta* is common but *T. indica* appears to be absent. These facts suggest that there is another larval food plant. The refusal of the larvae to feed on *P. alboflavescens* in the current study does not necessarily indicate that the plant is not used. The ♀ oviposited on the plant after much deliberation; perhaps the plant material offered to the larvae in the current study was unsuitable in some respect.

Tirumala limniace exoticus Gmelin, 1790 (Blue Tiger)

The final instar larva and pupa of *Tirumala limniace exoticus* were described by Moore (1880) from Sri Lankan material. The larva and pupa of *T. limniace* were described by Bell (1909) from Indian material and quoted by Woodhouse (1950). The descriptions of the larva agree with the findings of the current study except for the following points: in *T. l. exoticus*, a) spiracular band yellow to yellowish-brown and b) planta white (Fig. 6a). The descriptions of the pupa agree with the findings of the current study except for the following points: in *T. l. exoticus*, a) all spots that Bell described as golden are silver, b) spiracles oval to slit-like, and c) knobby transverse band on S7 silvery, not gold with a black streak below the band at the lateral edges. These differences may be significant in the identification of *T. l. exoticus* (Fig. 6b).

Additional notes on immature stages: Egg: white, cylindrical, tapered to apex, longitudinal ribs with numerous transverse ridges. 1st instar: Newly emerged—head dark brown, abdomen bluish creamy-white; after one day—head black, abdomen light brown with white transverse stripes apically and basally, S2 and S14 mostly white, filament buds on S3 and S12 (Fig. 6c). 2nd instar: similar to 1st instar except abdomen darker brown, filaments dark brown and longer (Fig. 6d).

Duration of immature stages: emergence to first molt 5 days; subsequent molts every 2–3 days (4 molts in all); pupation to eclosion 4–8 days; emergence to eclosion 19 days.

Larval food plants: In Sri Lanka, "*Asclepias*" was reported by Moore (1880). "*Dregia volubilis, Asclepias* and sometimes ...*Calotropis* or *Hoya*" were reported as larval food plants by Woodhouse (1950), based on Bell (1909) reporting from India. It should be noted that the generic names *Asclepias* and *Hoya* have been previously applied to other genera, for example, *Tylophora*, so it is impossible to determine to which species Bell or Moore referred.

The current study showed for the first time that one of the larval food plants in Sri Lanka is *Wattakaka volubilis* (syn. *Dregea volubilis*) (family Asclepiadaceae). It also showed that *Calotropis* is unlikely to be a larval food plant in Sri Lanka as all larvae tested refused to feed on *Calotropis gigantea.*

T. l. exoticus is very common in the dry and intermediate zones and can be seen at higher elevations while flighting. *W. volubilis* is common in the dry and intermediate zones (Dassanayake, 1983) up to about 1000 m asl. If *T. l. exoticus* is breeding in the higher elevations, there must be another larval food plant.

Tirumala septentrionis musikanos Fruhstorfer, 1910 (Dark Blue Tiger)

There are no records of the immature stages of *Tirumala septentrionis musikanos.* In the current study, the immature stages are described for the first time.

Notes on immature stages: On October 10, 2010, a ♀ was observed in Moneragala ovipositing on a plant and the eggs were raised successfully to eclosion but on *Wattakaka volubilis* leaves (H. D. Jayasinghe, pers. comm.). On December 4, 2010, the authors also observed a ♀ ovipositing in the same location on the same plant. This plant has been tentatively identified as *Heterostemma* cf *tanjorense* (family Asclepiadaceae). Larvae of various sizes were also found on several other plants nearby. The eggs and larvae were successfully raised to eclosion on the leaves of this plant as well as on leaves of *Wattakaka volubilis.*

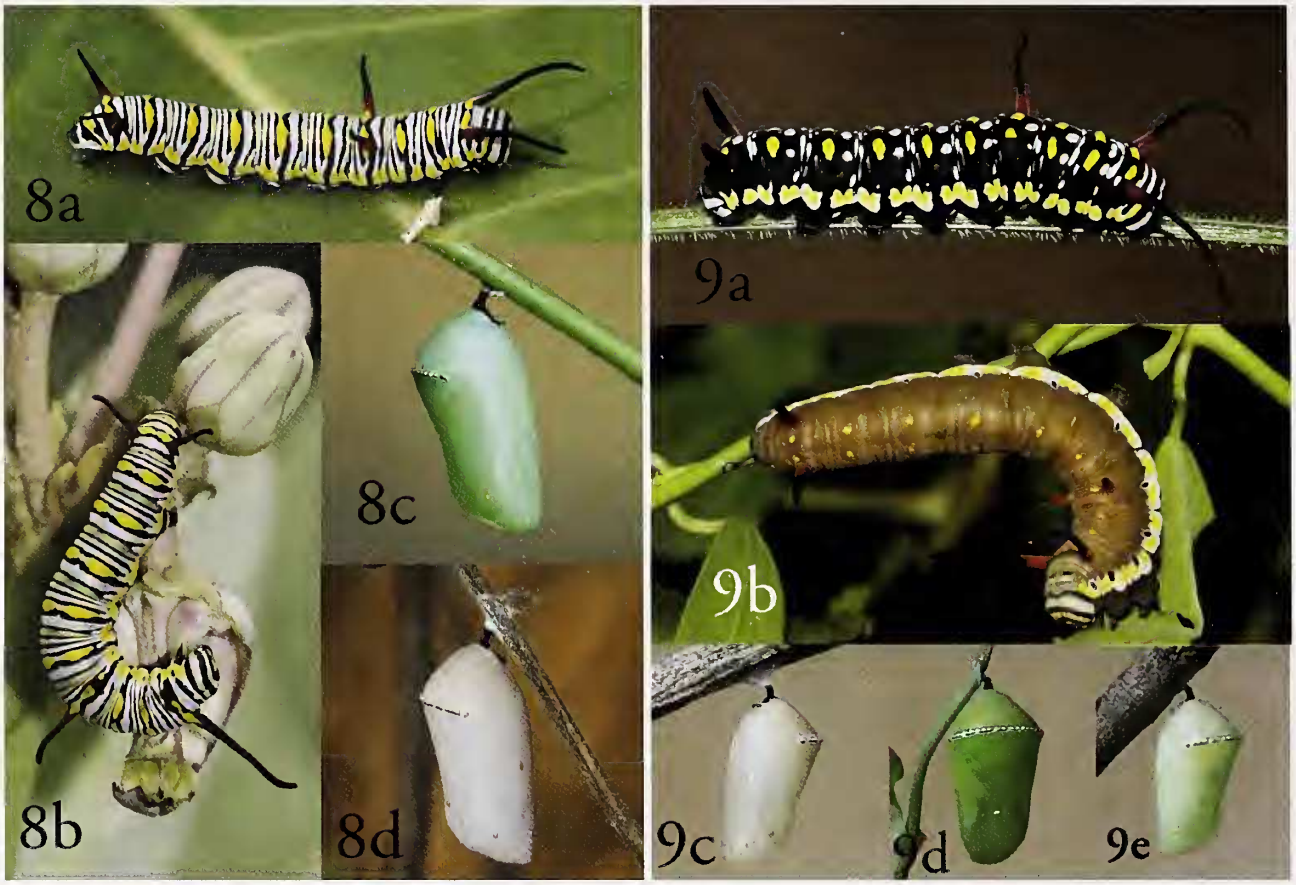
Egg: white, elongate, tapered to apex, flattened at base; 18 longitudinal ribs and numerous transverse ridges (Fig. 7a). 1st instar: newly emerged larva consumed its eggshell, then fed on the underside of the leaf; head black and abdomen white with black spot on S2 immediately after hatching; within a few hours abdomen green; one day later: abdomen yellowish-green with 2-3 light gray transverse bands

Figure 6-7. 6. *Tirumala limniace exoticus.* **6a.** Larva, final instar. **6b.** Pupa. **6c.** Larva, first instar showing method of feeding. **6d.** Larva, second instar, head capsule still adhering. **7.** *Tirumala septentrionis musikanos.* **7a.** Egg. **7b.** Larva, second instar, close-up of head. **7c.** Larva, second instar. **7d.** Larva, third instar, close up of head. **7e.** Larva, third instar. **7f.** Final instar, close up of head. **7g.** Larva, final instar. **7h.** Pupa, dorso-lateral view. **7i.** Pupa, dorso-lateral view. **7j.** Pupa, ventral view.

on each segment, S2 with black subdorsal spots, S3 dorsum flat with 2 very slight protuberances, S12 with 2 very slight protuberances, prolegs black. 2nd instar: head black with two light bluish-gray transverse stripes on the side, clypeus and base of antenna bluish-gray (Fig. 7b); abdomen light bluish-gray with dark maroon to brownish transverse stripes above the spiracular band, S2 with black subdorsal spot; stubby dark maroon filaments with white base on S3 and S12, obscure yellowish spiracular band, prolegs with white transverse band and black line below (Fig. 7c). 3rd instar: very similar to 2nd instar but filaments longer, and blue transverse bands on head longer and closer to dorsal line (Fig. 7d, e). 4th instar: filaments longer, white markings along filaments dorsally and ventrally extended towards the tip. 5th instar: blue bands on the head converge at the dorsum, much variation in the width of the dark transverse stripes which are closer to black, spiracular band more pronounced in some individuals while in others it is reduced to a series of disjointed dark yellow spots (Fig. 7f, g). Pupa: light green, cremaster black, silver spots variable but often seen on eye, wing bases and sub-dorsally on S2-S4; on S5, three silver spots (one dorsal, two subdorsal); S7 with knobby silver transverse band with short black band below at center and laterally (Fig. 7h, i, j).

Duration of immature stages: oviposition to emergence 2–4 days; emergence to 1st molt 2–3 days; 2nd instar 5 mm length; 1st to 2nd molt 1–2 days; 2nd to 3rd molt 2 days; 4th instar 20 mm length; 3rd to 4th molt 1–3 days; 5th instar 38 mm length immediately after molt; 4th molt to pupation 4–5 days; length at pupation 45 mm; emergence to pupation 21 days; pupation to eclosion 10 days.

Larval food plants: In Sri Lanka, "of the family Asclepiadaceae" was reported by Ormiston (1924). However, this record seems to have been based on MacKinnon & de Nicéville (1897) who recorded the



Figures 8-9. 8. *Danaus chrysippus chrysippus.* **8a.** Larva, final instar. **8b.** Final instar, feeding on flower buds of *Calotropis gigantea.* **8c.** Pupa, green form. **8d.** Pupa, whitish form. **9.** *Danaus genutia genutia.* **9a.** Larva, final instar, purplish maroon form. **9b.** Final instar, brown form. **9c.** Pupa, straw-colored. **9d.** Pupa, green. **9e.** Pupa, light green.

larval food plant for *T. septentrionis* in the Dun, India as *Vallaris dichotoma* (family Asclepiadaceae). The current study showed for the first time that one of the larval food plants in Sri Lanka is *Heterostemma* cf *tanjorense* (family Asclepiadaceae). A ♀ was observed in the Nitre Cave area in the Knuckles ovipositing on another plant (a large vine) that is yet unidentified (H. D. Jayasinghe, pers. comm.). *H. tanjorense* has not been recorded from this area.

Heterostemma tanjorense is reported as being rare in the wet zone but "not uncommon in the dry country along the east coast (Trincomalee to Amparai Districts)" (Dassanayake, 1983). It has not previously been recorded from Moneragala.

Although *T. s. musikanos* was earlier reported to be very common and widely distributed in the island (Woodhouse, 1950), it now appears to be common only in the plains of the east and southeast. It is uncommon in the northwest, scarce in the west and southwest, and seen in the hills only during migrations.

The distribution of *Heterostemma tanjorense* fits with most, but not all, of the distribution of *T. s. musikanos,* though it is possible that the distribution of *H. tanjorense* has not been fully documented. *Vallaris solanacea* is the species found in Sri Lanka though it is rare and not found where the butterfly is. There are no records of either species being used as larval food plants in Sri Lanka. Though the larvae were raised successfully on *Wattakaka volubilis* in the lab, there is no evidence that it feeds on this plant in the field.

Danaus chrysippus chrysippus (Linnaeus, 1758) (Plain Tiger)

The final instar larva and pupa of *Danaus chrysippus chrysippus* were described from Sri Lankan material by Moore (1880) and by Tunnard (Woodhouse, 1950). The larva and pupa of *D. chrysippus* were described

by Bell (1909) from Indian material and quoted by Woodhouse (1950). In general, these descriptions of the larva agree with the findings of the current study except for the following point: in *D. c. chrysippus*, only S14 has yellow spots wanting (S2 & S13 also wanting in Bell 1909) (Fig. 8a, b). These descriptions of the pupa also agree with the findings of the current study except for the following points: in *D. c. chrysippus*, on S7, a) there is only a single row of beads (double row reported by Bell); and b) the transverse band is golden above, then silver, then black below (Bell records only gold and black) (Fig. 8c, d).

Additional notes on immature stages: Egg: white, cylindrical, domed at apex, broadly flattened at base.

Larval food plants: In Sri Lanka, *Calotropis gigantea* and *Asclepias curassavica* were reported by Moore (1880), and *Gomphocarpus physocarpus* was reported by Tunnard (Woodhouse, 1950). The current study confirmed these three species as larval food plants in Sri Lanka and showed for the first time another new larval food plant: *Pentatropis capensis* (family Asclepiadaceae). The larva feed on leaves, flowers and flower buds of *Calotropis gigantea*, and on the leaves of *Pentatropis capensis*.

D. c. chrysippus is common over most of the island. *C. gigantea* is the most widely used larval food plant in the arid, dry and intermediate zones though the butterfly seems to have its highest preference for *A. curassavica*, a cultivated plant. *P. capensis* and *C. gigantea* are used in the dry coastal areas. When *P. capensis* was grown further inland (45 km) from the coast in the intermediate zone where it is not naturally found, adults of *D. c. chrysippus* did not use it for oviposition—perhaps the populations in this zone are sufficiently differentiated to feed on other plants. *A. curassavica* and *G. physocarpus* (a naturalized introduction) are used in the mid- and high elevations. It is possible that there is another larval food plant that is a native plant at the higher elevations.

Danaus genutia genutia (Cramer, 1779) (Common Tiger)

The final instar larva and pupa of *Danaus genutia genutia* were described briefly by Moore (1880) from Sri Lankan material. The larva and pupa of *D. genutia* were described by Bell (1909) from Indian material and were quoted by Woodhouse (1950). In general, these descriptions of the larva agree with the findings of the current study except for the following point: in *D. g. genutia*, the ground color of the larva is seldom black (as recorded by Bell) but is usually dark purplish-maroon to light brown (Fig. 9a, b). These descriptions of the pupa agree with the findings of the current study except that in *D. g. genutia*, the color of the pupa varies from pale straw-colored to green (Fig. 9c, d, e).

Additional notes on immature stages: Egg: white, elongate, tapered to apex, flattened at base.

Larval food plants: There are no published records of the larval food plant in Sri Lanka. The current study showed for the first time that the following are larval food plants in Sri Lanka: *Oxystelma esculentum*, *Cynanchum tunicatum* and *Tylophora tenuissima*.

Although Woodhouse (1950) reported *Stephanotis* spp., *Raphis pullchellum* [*sic*], *R. lemma*, *Passularia*, *Ceropegai* [*sic*] *intermedia*, this was based on Indian records quoted in Bell (1909) and Moore (1890-92). Moore (1890-92) quoted *Raphis pulchellum* after Chaumette, *Raphis lemma* and *Passularia* after Grote and *Ceropegia intermedia* after Elliot. None of these plants is found in Sri Lanka except for *C. intermedia* (now *Ceropegia candelabrum*). *Raphis pulchellum* and *R. lemma* seem to be written in error. The genus *Raphis* is of the family Poaceae (Grasses) and is unlikely to be a larval food plant for this butterfly. *R. pulchellum* and *R. lemma* are likely to be *Raphistemma pulchellum* (family Asclepiadaceae) though this genus is not found in Sri Lanka. *Passularia* also appears to be written in error as there is no such genus and perhaps what was meant was *Passerina* (Thymelaeaceae family), which is a genus that is also not found in Sri Lanka. *Ceropegia candelabrum* is widely distributed in the dry zone and extends into the wet zone (Dassanayke, 1983), but its use as a larval food plant has so far not been recorded.

D. g. genutia is common and found over most of the island and appears to use different larval food plants depending on the region. *Cynanchum tunicatum* is not uncommon in the drier areas of the island (Dassanayke, 1983). *Oxystelma esculentum* is more common in swampy areas of the dry coastal belt (Dassanayke, 1983). *Tylophora tenuissima* was used in the mid-elevations at Soragune (Haldumulla) and at Kurunegala in the intermediate zone.

Subtribe: Euploeina

Euploea core asela Moore, 1877 (Common Indian Crow)

The final instar larva and pupa of *Euploea core asela* were described from Sri Lankan material by Moore (1880) and by Tunnard (Woodhouse, 1950). The larva and pupa of *E. core* were described by Bell (1909) from Indian material and quoted by Woodhouse (1950). These descriptions of the larva and pupa agree with the findings of the current study except for the following point: in *E. c. asela*, in the pupa, the ground color is highly variable, ranging from yellow to lemon-

green to beige to brown (Fig. 10a, b, c, d, e, f).

Additional notes on immature stages: Egg: yellowish, cylindrical but wider sub-apically, tapered at apex, honey-comb-like depressions. 1st instar: newly emerged larva—head black, abdomen uniformly pale green, last segment green or with a black spot, legs black; 1 day later—abdomen brownish-yellow with tiny filament buds.

Duration of immature stages: oviposition to emergence 3 days; emergence to first molt 2 days; next 3 molts every 1–3 days; length of larva before pupation 55 mm; length of pupa 21 mm; pupation to eclosion 6 to 10 days; oviposition to eclosion 18 to 23 days.

Larval food plants: In Sri Lanka, "*Nerium oleander*, &c." was reported by Moore (1880), and *Nerium oleander* and *Ficus religiosa* were reported by Tunnard (Woodhouse 1950). Tunnard also reported that the larvae fed on *Gomphocarpus physocarpus* though the ♀ did not oviposit on that plant.

The current study confirmed *N. oleander*, *F. religiosa* and *G. physocarpus* as larval food plants in Sri Lanka. It also showed for the first time that the following plants are larval food plants in Sri Lanka: *Ficus pumila*, *Ficus benjamina* (family Moraceae); *Cryptolepis buchananii*, *Hemidesmus indicus* (family Periplocaceae); *Adenium obesum*, *Allamanda cathartica*, *Parsonsia alboflavescens*, *Ichnocarpus frutescens* (family Apocynaceae); and *Pentatropis capensis* (family Asclepiadaceae). Larvae have also been successfully reared on a plant near Soragune, Haldumulla called 'gon-na' in Sinhalese (S. Sanjeewa, pers. comm.). This plant has been tentatively identified as *Ochrosia oppositifolia* (family Apocynaceae).

E. c. asela is common over most of the island. The larva feeds on a variety of widely distributed common plants and appears to show regional differences in larval food plant preferences. For example, *E. c. asela* was found to feed on *Pentatropis capensis* in Arippu (Mannar) in the arid zone on the west coast but it feeds preferentially on *Cryptolepis buchananii* in the wetter areas of the island and on *Ichnocarpus frutescens* in the intermediate zone. There may be other larval food plants.

Euploea klugii sinhala Moore, 1877 (Brown King Crow)

The final instar larva and pupa of *Euploea klugii* were described by Bell (1909) from Indian material and quoted by Woodhouse (1950). This description of the larva and pupa agrees with the findings of the current study except for the following points: in the larva of *E. k. sinhala*, a) the spiracular band has variable amounts of orange, sometimes equal to the white; and b) the lower half of the filaments is claret-red while the upper half is black. In addition, Bell's statement that the front pair of filaments are generally held curled only in *E. klugii* does not agree with the observations of the current study; they are also curled in *E. sylvester montana* (Fig. 11a, b, c).

Additional notes on immature stages: Egg: pale yellow, cylindrical, domed at apex, honey-comb-like depressions (Fig. 11d). 1st instar (newly emerged larva): blackish-brown head, honey-colored body, tiny filament buds. 2nd instar: head black, abdomen with faint whitish transverse bands and short, light brown filaments (Fig. 11e).

Duration of immature stages: hatching to 1st molt 1 day; the next 3 molts every 1–2 days; pupation took 2 days to complete; pupation to eclosion 7 days; hatching to emergence 15 days.

Larval food plants: There are no published records of the larval food plants in Sri Lanka. The current study showed for the first time that one of the larval food plants in Sri Lanka is *Streblus asper* (family Moraceae). Although Woodhouse (1950) reported "*Ficus hispida*; doubtless other figs as well" as larval food plants, this was based on Bell (1909) reporting from India. In the current study, the larvae refused to feed on *Ficus hispida*.

E. k. sinhala is widely distributed over the island but is most common in dry semi-deciduous monsoon forests where *S. asper* is quite common (Dassanayake, 1981). Since both *E. k. sinhala* and *S. asper* occur sparingly elsewhere, *S. asper* may be the only larval food plant in Sri Lanka though it is possible that another one will be discovered.

Euploea phaenareta corus Fabricius, 1793 (The Great Crow)

The final instar larva and pupa of *Euploea phaenareta corus* were described by Moore (1880). The descriptions were based on a drawing in Horsfeld & Moore (1857) of a specimen from Sri Lanka. This description of the larva and pupa agrees with the findings of the current study except for the following points: in the larva of *E. p. corus*, a) the color of the abdomen, filaments and markings are variable; and b) the subspiracular line is orange or yellow. The current study describes all stages for the first time.

Additional notes on immature stages: On July 20, 2006, a ♀ was observed laying eggs on *Cerbera odollam* (family Apocynaceae). Eggs were laid singly on the underside of tender leaves. The eggs were successfully reared to eclosion.

Egg: whitish-yellow, cylindrical, domed at the apex, with honey-comb-like depressions (Fig 12a). 1st instar: Newly emerged larva ate part of the eggshell;

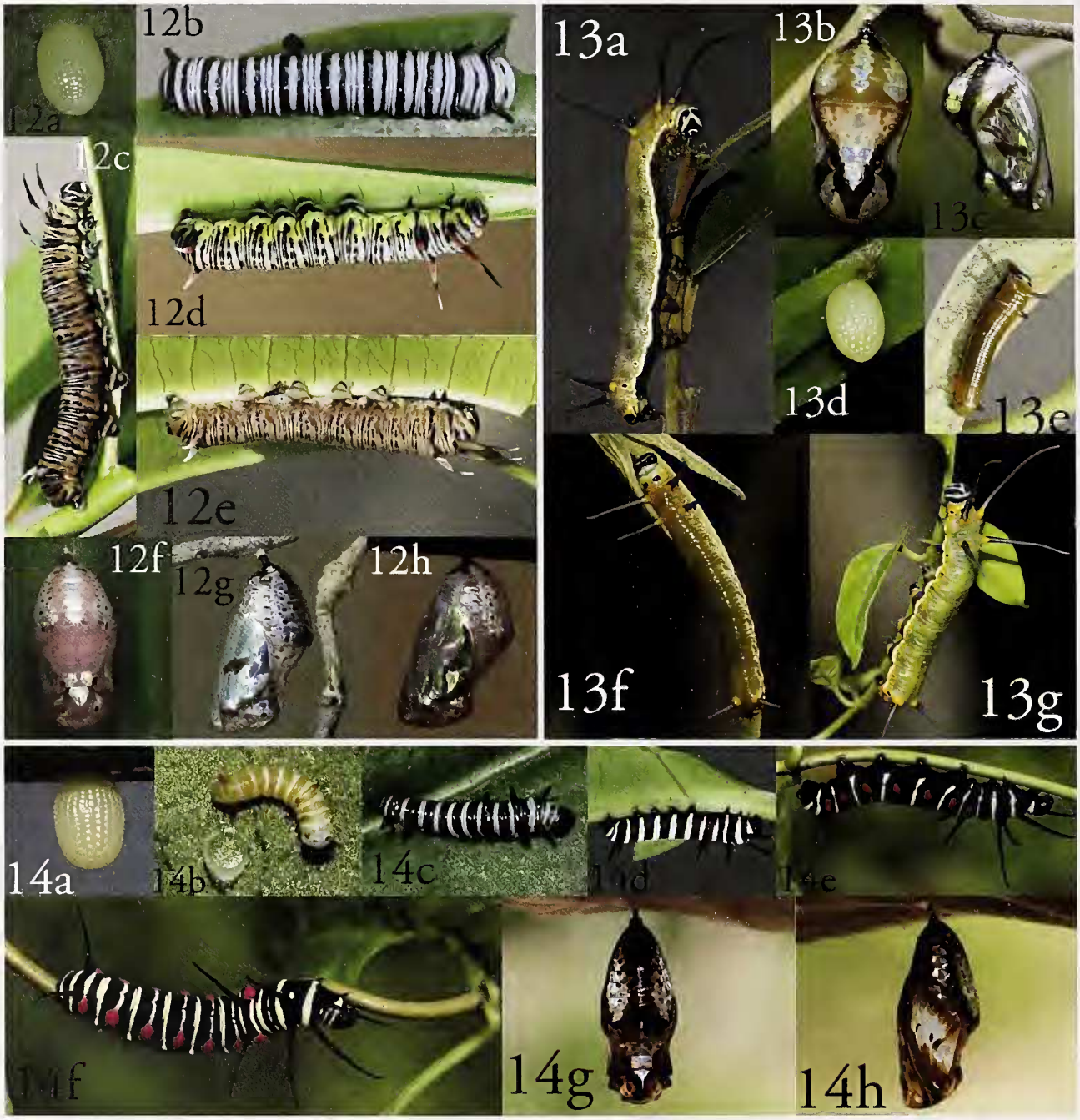
Figures 10-11. 10. *Euploea core asela*. **10a**. Larva, final instar, purple form. **10b**. Final instar, brown form. **10c**. Pupa. **10d**. Pupa. **10e**. Pupa. **10f**. Pupa. **11.** *Euploea klugii sinhala*. **11a**. Larva, final instar, white spiracular line with orange. **11b**. Larva, final instar, orange spiracular line with white. **11c**. Pupa, lateral view. **11d**. Egg. **11e**. Larva, second instar.

then fed both on tender leaves (where it remained on the upperside of the leaf) and on older leaves (where it remained on the underside); head black, body whitish with black transverse stripes, no filaments, 5 mm in length. 2nd instar: white with black transverse stripes, filaments on S3, S4 and S12 black, 9 mm in length (Fig. 12b). 3rd instar: ground color variable and filaments colored as in fifth instar, 12 mm in length. 4th instar: similar to 3rd instar, 22 mm in length (Fig. 12c). 5th instar: head black with white v-shaped band along the adfrontal area, laterally a white band that joins at the top, clypeus light blue; abdomen, smooth cylindrical, ground color variable from light brown to almost white with black transverse bands, of variable thickness; spiracular band irregular, much convoluted, light brown to cream-colored or yellow; filaments with colors variable (S3 & S4—larvae with a brown ground color have filaments that are light brown at the base, then black in the middle with white tips; those with a whitish ground color have filaments that are claret red at the base with black or white tips); filaments on S3 longest and point forward; those on S12 shortest and point backwards and without black (only brown and white or claret red and white or all white); base and crochets of prolegs white, planta black; 27 mm in length immediately after the molt, 50 mm in length just before pupation (Fig. 12 d, e).

Pupation occurred on same tree on which the larva fed and took 2 days to complete. The ground color of the pupa is silvery gray and beige or pinkish; abdominal segments convex; lateral margin of the abdomen with a band of dark brown to black spots above the spiracular line (Fig. 12 f, g, h).

Duration of immature stages: oviposition to emergence 5 days; 4 molts, every 2–3 days; pupation to eclosion 8–12 days; emergence to eclosion 19–24 days.

Larval food plants: There are no published records of the larval food plant in Sri Lanka. The current study showed for the first time that one of the larval



Figures 12-14. **12.** *Euploea phaenareta corus*. **12a**. Egg. **12b.** Larva, second instar. **12c**. Larva, fourth instar. **12d**. Larva, final instar. **12e**. Larva, final instar. **12f**. Pupa, pink ground color, dorsal view. **12g**. Pupa, beige ground color, lateral view. **12h**. Pupa, pink ground color, lateral view. **13**. *Euploea sylvester montana*. **13a**. Larva, final instar. **13b**. Pupa, dorsal view. **13c**. Pupa, lateral view. **13d**. Egg. **13e**. Larva, second instar. **13f**. Larva, third instar. **13g**. Larva, fourth instar. **14**. *Idea iasonia*. **14a**. Egg. **14b**. Larva, newly emerged with eaten eggshell. **14c**. Larva, second instar. **14d**. Larva, third instar. **14e**. Larva, final instar, lateral view. **14f**. Larva, final instar, dorsal view. **14g**. Pupa, dorsal view. **14h**. Pupa, lateral view.

food plants in Sri Lanka is *Cerbera odollam* (family Apocynaceae).

C. odollam is a medium-sized tree that is fairly widespread along the east and west coast in both the wet and dry zones. It is also frequently planted along roads and the edges of rice fields. Where it occurs naturally, it tends to grow in shady locations; when planted it survives quite well in open sunny areas.

E. p. corus is locally common along the south-west coast from Negombo to Galle and up to 15 km inland, preferring shady habitats such as mangroves and well-wooded marshy areas.

The distribution of *E. p. corus* maps well with the distribution of *C. odollam* along the west coast where the plant occurs naturally in shade. However, *E. p. corus* does not colonize trees that have been planted in open sunny areas. Nor has it been recorded from the mangroves on the east and north coast despite the presence of *C. odollam*. Manders (1904) suggested that *E. p. corus* may have been accidentally introduced into the port of Galle from China and spread from there. This would account for the distribution.

However, there is also one population of *E. p. corus* in the Sinharaja Forest Reserve, 45 km from the coast. It probably arrived and established itself there with the planting of *C. odollam* alongside the rice fields adjacent to the forest. The rice fields have long been abandoned and the land is now protected under the stewardship of the Ministry of the Environment. *E. p. corus* still thrives there, but only along the trail that borders the rice fields where *C. odollam* still grows. *C. odollam* is probably the only larval food plant for *E. p. corus*.

Euploea sylvester montana Felder & Felder, 1865 (Double Branded Black Crow)

The final instar larva and pupa of *Euploea sylvester* were described by Bell (1909) from Indian material and quoted by Woodhouse (1950). This description of the larva and pupa agrees with the findings of the current study except for the following points: in the larva of *E. s. montana*, a) filaments on S3 are curved and b) legs are brown (Fig 13a, b, c). The current study describes all stages for the first time.

Additional notes on immature stages: Egg: white, cylindrical, domed at apex, flattened at base, honeycomb-like depressions (Fig. 13d). 1st instar (newly emerged larva): head black, body golden-brown, filaments on S3, S4 and S12 short and brown. 2nd instar: head black with white transverse stripes, body yellowish-brown, subspiracular line whitish, filaments light brown, S14 black, legs black (Fig. 13e). 3rd instar: head black with white transverse stripes, body brownish-green, subspiracular line white, S2 with 2 black dorsal spots surrounded by yellow and 2 smaller black spots laterally, filaments smoky gray and bright yellow or orange at base, longest filament on S3, legs brownish-green with black marking, S14 with black spot posteriorly (Fig. 13f). 4th instar: head black with white transverse stripes, body light grayish-green, white subspiracular line with pale orange above and gray below, filaments dark gray with orange base, spiracles black, S2 orange with 2 black dorsal spots and 2 smaller black spots laterally (Fig. 13g). 5th instar: head black with white stripes, body grayish-green, white subspiracular line, spiracle on S12 very prominent, filaments dark gray with yellow or orange base, anal flap black, all spiracles black and ringed with white, S2 with 2 black transverse dorsal markings and 2 lateral ones.

Duration of immature stages: hatching to first molt 4 days (length 12 mm); successive molts every 1–2 days (4 molts in all); last instar 52 mm in length before pupation; length of pupa 19 mm; pupation to eclosion 9 days; hatching to eclosion 20 days.

Larval food plants: There are no published records of the larval food plant in Sri Lanka. The current study showed for the first time that one of the larval food plants in Sri Lanka is *Gymnema sylvestre* (family Asclepiadaceae). Although Woodhouse (1950) reported *Ichnocarpus frutescens* (family Apocynaceae) as the larval food plant, this was based on Bell (1909) reporting from India. In the current study, the larvae refused to feed on *I. frutescens*.

G. sylvestre is not very common but is found in the dry and intermediate zones up to about 1000 m asl (Dassanayake, 1983).

E. s. montana is not common but is widely distributed over most of the island up to about 1000 m asl. Since the distribution of *G. sylvestre* does not fit that of *E. s. montana*, it is likely that there is another larval food plant.

Idea iasonia Westwood, 1848 (Sri Lankan Tree Nymph)

The final instar larva of *Idea iasonia* (which is endemic to Sri Lanka) was described by de Nicéville and Manders (1899) but the description was based on a colored drawing that was sent to de Nicéville by Mr. E. Ernest Green from Sri Lanka. This general description agrees with the findings of the current study which describes all stages for the first time.

Additional notes on immature stages: On March 16, 2007, the authors observed a ♀ *I. iasonia* in the Knuckles area ovipositing on the leaf of a plant that was later identified as *Parsonsia alboflavescens* (family Apocynaceae). Eggs were laid singly on the underside of leaves, low to the ground, on young plants that were in dense shade. The plants used were not more than a meter high even though *P. alboflavescens* is a vine that grows to several meters long and reaches the canopy. The eggs were collected and reared to eclosion. Larvae were also collected from the underside of a leaf, low to the ground, and were raised

to eclosion. Eggs and larvae were also collected from *P. alboflavescens* in the Knuckles area one month later, and also raised to eclosion. *I. iasonia* was also observed ovipositing on *P. alboflavescens* in the Sinharaja Forest Reserve as well and larvae were raised successfully to eclosion. All adults that eclosed were normal and were released to their places of origin.

Egg: white, cylindrical, domed at the apex, flattened at the base with honey-comb-like depressions (Fig. 14a). 1st instar (newly emerged larva): consumed most of the eggshell, then moved to the underside of the leaf and fed by gnawing away the lower epidermis and the cells beneath but leaving the upper epidermis intact; head black; body pale yellow-brown and somewhat transparent; S5, S6, S7 and S8 with a tinge of green; two white transverse bands on each of S3 to S13, broadest dorsally, one apical, one basal; S3, S4, S6 and S12 with paired fleshy filaments on either side of the dorsal line; filaments short and stubby, basally pale yellow-brown, distally dark brown; S2 white, with two dark gray spots dorsally, more or less lined up with the paired filaments behind; legs black (Fig. 14b).

2nd instar: Molt eaten as its first meal, except for the head shield. Ground color velvety black; skin smooth and glossy; spiracles black; pale yellow transverse bands extend ventrally to just above the base of the prolegs; anterior and posterior transverse bands on S2 usually coalesced on the lateral margins and dorsally, leaving two black patches dorsally; paired subdorsal filaments on S3, S4, S6, and S12, long and slightly curved; filaments on S3 often pointing forwards over the head; those on S12 held vertically, often with the tip pointing backwards; S6 to S12 with a lateral, oval dark reddish-pink spot which is sometimes indented irregularly. The larva fed from the margins of the plant but continued to remain on the underside of the leaf, quite sedentary and well concealed (Fig. 14c).

3rd instar: similar to 2nd instar. Molt eaten. In each pair of transverse bands, the anterior one is shorter than the posterior one and is of variable length. Sometimes a small lateral spot in S5 near the spiracle, similar in color to those on S6 through S12 (Fig. 14d).

4th instar: Molt eaten. Similar to 3rd instar but the transverse bands on adjacent segments merge to form a single pale yellow line in most larvae; pads on prolegs more or less transparent.

5th instar: Molt eaten. Similar in color and markings to 4th instar larva but in most larvae, the paired lateral spots on each segment are joined dorsally by a pale yellow irregular transverse band (Fig. 14e, f). *Idea malabarica*, the closely related Indian species, lacks the paired spots on S12 (Talbot, 1947).

Pupa: Silk pad glistening and coppery. 30 mm in length and 10 mm at its widest point. Ground color metallic orange-brown. Numerous black spots over much of the surface. Stalk black with two small protuberances beyond the end of the abdomen. Head light reddish-brown. Silver markings on eyes. Thin silver transverse line on S2. Triangular silver marking on dorsal line of S3. A square silver patch on S4. Wings with silver markings at the base. A broader rectangular silver patch on S5, usually with black spots. S6 reddish-brown with silver dorso-lateral patch posteriorly. S7 to S10 reddish-brown with silver dorso-lateral band with numerous black spots increasing in density towards S10. S11–S12 without silver. S13–14 dark reddish-brown with orange dorsal transverse band (Fig. 14g, h).

Most of the 4th and 5th instar larvae found in the field were amongst dense foliage within 1 m of the ground. Although no pupae were found in the field, it is very likely that pupation occurs within these dense stands of vegetation.

Duration of immature stages: oviposition to emergence 4–5 days; molting every 3–5 days (4 molts); fully grown larva about 50 mm long; pupation took 2 days to occur on average; pupation to eclosion 8–14 days; oviposition to eclosion 32–33 days (An exception was 2 eggs that were collected in October 2008 in which molting occurred every 2–3 days and the time from oviposition to eclosion was 25 days.)

Larval food plants: In Sri Lanka, "a climbing asclepidaceous plant allied to *Hoya*" was reported by de Nicéville and Manders (1899) based on a drawing. The current study showed for the first time that one of the larval food plants in Sri Lanka is *Parsonsia alboflavescens* (family Apocynaceae). Though several authors reference *Hoya* as a larval food plant, these citations seem to be a misinterpretation of de Nicéville's original note. Since the generic term *Hoya* has referred in past nomenclatures to other genera such as *Wattakaka* or *Tylophora*, it is not possible to ascertain the plant species to which de Nicéville referred. Both species of *Hoya* that are found in Sri Lanka (*H. pauciflora* and *H. ovalifolia*) are rare and there are no confirmed records of *Hoya* as a larval food plant.

P. alboflavescens is widely distributed in the wet, intermediate and dry zones and along the coast up to about 1000 m asl (Dassanayake, 1983).

I. iasonia is a forest-loving species that is usually found near streams between 500 m to 2000 m asl, though it also descends to sea level on the southern slopes of the wet zone. The butterfly is absent from many locations where the larval food plant occurs despite the apparent availability of suitable habitats.

On the other hand, *P. alboflavescens* has not been recorded from all areas where the butterfly has been seen (e.g. Agrapatana), which suggests the existence of another larval food plant.

Conclusion

The current study has confirmed some previously recorded larval food plants and has identified some new larval food plants. It has also shown that there are differences between the descriptions of the larva and pupa found in this study and the descriptions that have been done by other authors including those working on Sri Lankan material as well as Indian material. These differences may be due to natural variation or may be associated with the Sri Lankan subspecies. They may also depend on the larval food plant, which is sometimes different than that previously described. Many larval food plants that are used in India are not used by the same species in Sri Lanka or are used less preferentially. It is possible that the Sri Lankan subspecies may have evolved sufficiently to deviate from the larval food plants used in peninsular India and elsewhere. Evidence indicates that populations differ in their preference of larval food plant depending on the climatic region in which they live.

Acknowledgements

Chamitha de Alwis, Himesh Dilruwan Jayasinghe and Sarath Sanjeeva for field assistance and observations. Krushnamegh Kunte for a critical review of the manuscript and numerous fruitful discussions.

Literature cited

Bell, T. R. 1909. Common butterflies of the plains of India (including those met with in hill stations of the Bombay presidency), Journal of the Bombay Natural History Society 19: 49-57.

d'Abrera, B. 1998. The butterflies of Ceylon. Wildlife Heritage Trust, Colombo.

Dassanayake, M. D. 1981. A revised handbook to the Flora of Ceylon, Vol. 3. Oxford & IBH Publishing Co., New Delhi.

Dassanayake, M. D. 1983. A revised handbook to the Flora of Ceylon, Vol. 4. Amerind Publishing Co., New Delhi.

De Nicéville, L. & N. Manders. 1899. A list of the butterflies of Ceylon, Journal of the Asiatic Society of Bengal (Calcutta) 68 (2): 170-233.

Horsfeld, T. & F. Moore. 1857. A catalogue of the Lepidopterous insects in the Museum of the Honorable East-India Company, Vol. I. Wm. H. Allen & Co., London.

MacKinnon, P. W. & De Nicéville, L. 1897. A list of the butterflies of Mussoorie in the Western Himalayas and neighbouring regions, Journal of the Bombay Natural History Society 11: 205-221, Pls. U, V, W.

Mackwood, F. M. 1919. Insect food plants, Spolia Zeylanica 10: 79.

Manders, N. 1903. Notes on Ceylon Butterflies, Journal of the Bombay Natural History Society 14(4): 716-718.

Manders, N. 1904. The Butterflies of Ceylon, Journal of the Bombay Natural History Society 16(1): 76-85.

Moore, F. 1880. The Lepidoptera of Ceylon, Vol. I. L. Reeve & Co. London.

Moore, F. 1881. The Lepidoptera of Ceylon, Vol. III. L. Reeve & Co. London.

Moore, F. 1890-92. Lepidoptera Indica, Vol. I, Rhopalocera, Family Nymphalidae, Sub-families Euploeinae and Satyrinae. L. Reeve & Co., London.

Ormiston, W. 1924. The Butterflies of Ceylon. H. W. Cave & Co., Colombo.

Sri Lanka, Ministry of Forestry and Environment. 1999. Biodiversity Conservation in Sri Lanka: A framework for action.

Talbot, G. 1947. The fauna of British India including Ceylon and Burma: Butterflies. Vol. 2. Taylor and Francis, Ltd., London.

Woodhouse, L. G. O. 1950. The butterfly fauna of Ceylon, Second complete edition. The Colombo Apothecaries' Co. Ltd., Colombo.

APPENDIX A – Annotated list of the major scientific publications on the butterflies of Sri Lanka.

1. The Lepidoptera of Ceylon by F. Moore, 1880, 1881. Vol. 1 & Vol. 3 (in part). Descriptions of the adult as well as descriptions of many of the larvae and pupae with larval food plants. Presumably based on Sri Lankan specimens.

2. The Butterflies of India, Burmah and Ceylon by G. F. L. Marshall & L. de Nicéville—Vol. 1, 1882-83; by de Nicéville—Vol. 2, 1886 & Vol. 3. 1890. Descriptions of the larva and pupa of Sri Lankan species largely based on Moore (1880). Few larval food plants listed.

3. The Fauna of British India including Ceylon and Burma: Butterflies by C. T. Bingham, 2 volumes, 1905 & 1907. Information on larval stages and larval food plants of Sri Lankan species mostly quoted from Moore (1880).

4. The Fauna of British India including Ceylon and Burma: Butterflies by G. Talbot, 2 volumes, 1939 & 1947. Talbot included information on larval stages and larval food plants mostly quoted from Bell (1909).

5. Notes on Ceylon Butterflies by W. Ormiston, 1918. Spolia Zeylanica XI (part 40): 1-69 with two plates and XI (part 41): 126-188 with seven plates (II to VIII [*sic*]). Detailed descriptions of adult butterflies and distinguishing characteristics including genitalia but little information on larvae or pupae or larval food plants.

6. The Butterflies of Ceylon by W. Ormiston, 1924. Essentially an edited copy of the 1918 publication with additional information. Appendix B lists larval food plants and the sources are listed as "Mainly taken from the writings of" Moore, de Nicéville and Bell.

APPENDIX A (Cont.)

7. The Identification of Indian Butterflies by W. H. Evans, 1927 & 1932. Mostly identification keys; no immature stages or larval food plants.

8. 8a. The Butterfly Fauna of Ceylon by L. G. O. Woodhouse and G. M. R. Henry,1942. Ceylon Journal of Science [no volume designated]. First complete edition.
8b. The Butterfly Fauna of Ceylon by L. G. O. Woodhouse, 2nd (complete) edition, 1949.
8c. The Butterfly Fauna of Ceylon by L. G. O. Woodhouse, 2nd (abridged) edition, 1950.
All editions included descriptions of larvae, pupae and larval food plants mostly based on Moore (1880) from Sri Lankan material and Bell (1909) from Indian material and with field notes of Tunnard, E. E. Green etc. from Sri Lankan material.

9. The Butterflies of Ceylon by B. d'Abrera, 1998. Descriptions of larvae, pupae and larval food plants mostly based on Woodhouse but with some personal observations.